Public Service Commission of Wisconsin
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Public Service Commission of Wisconsin Office of Energy Innovation
Critical Infrastructure Microgrid and Community Resilience Center Pilot Grant Program

ATTACHMENT A - COVER SHEET

SECTION I - Provide information summarizing the project proposal.				
Project Title:	Microgrid for Appleton International Airport			
PSC Grant Request ($):	**Applicant Cost Share ($):**	**Project Total ($):**		
$100,000	$142,927	$242,927		
Choose one Eligible Activity				
☐ Critical Infrastructure Microgrid Feasibility Study Level 1 and 2	☒ **Critical Infrastructure Microgrid Feasibility Study Level 3**	☐ Community Resilience Center Feasibility Study		
SECTION II - Provide information for your organization, signatory, and primary contact for the project.				
Applicant Type:	☐ City	☐ Village	☐ Town	☒ **County**
☐ Tribal Nation	☐ Wisconsin Technical College System			
☐ University of Wisconsin System	☐ K-12 School District	☐ 501(c)(3) nonprofit		
☐ Municipal Utility (water, wastewater, electric, natural gas)	☐ Hospital (public or nonprofit)			
Name (on W-9):	Appleton International Airport			
Address (on W-9):	W6390 Challenger Dr, Appleton, WI, 54914			
County or Counties Served by Project:	Outagamie			
DUNS Number or CAGE Code:	118620140 (DUNS) or 321F4 (CAGE)			
NAICS Code:	488119			
Authorized Representative/Signatory (Person authorized to submit applications and sign contracts)		**Primary Contact** (if different from Authorized Representative)		
Name:	Jenna DeShaney	**Name: Scott Volberding**		
Title:	Environmental Scientist	**Title: Operations and Maintenance Manager**		
Phone:	920-830-6115	**Phone: 920-832-5176**		
E-mail:	jenna.deshaney@westwoodps.com	**E-mail: svolberding@atwairport.com**		
Signature of the Authorized Representative	Jenna DeShaney			

Appleton International Airport
Microgrid for Appleton International Airport

Summary of Project Budget				
Line	**Description**	**PSC Grant Request**	**Applicant Cost Share**	**Total Project Cost**
1	Personnel		$15,000	$15,000
2	Fringe			$0
5	Travel			$0
6	Contractual	$100,000	$127,927	$227,927
7	Other			$0
8	Indirect			$0
	Totals	$100,000	$142,927	$242,927
	% of Total	**41%**	**59%**	

Applicant Comments:

Appleton International Airport (applicant): Cost Share = $142,927, Grant Request = $100,000.

The grant request would fund contracts with HGA, Mead & Hunt, and Westwood.

The applicant cost share would cover remaining consultant costs and personnel costs.

3.3 APPLICATION NARRATIVE

3.3.1 Project Description

The overarching goal of this proposed project is to construct a microgrid at Appleton International Airport (the Airport). In order to achieve this goal, an in-depth feasibility study is required. The Airport is applying for the Critical Infrastructure Microgrid & Community Resilience Center Grant to alleviate a portion of the financial demands associated with a feasibility study for the microgrid.

The motivation behind this project originates from the sustainability goals established in the Airport's 2012 Master Plan. Since the mid-2000s, the Airport has incorporated various sustainable initiatives throughout airport operations. These sustainable initiatives include solar thermal hot water system, ground power and pre-conditioned air units, biofiltration basin, rooftop and carport solar photovoltaics (PV), LED upgrades, on-site hydroponics farming system, the construction of a class D Net Zero Energy General Aviation Building, and more. In 2011, Appleton International Airport was one of ten airports selected by the Federal Aviation Administration (FAA) to participate in a Sustainable Master Plan Pilot Program. Two sustainability goals were created from this 2012 Master Plan:

(1) To achieve a 70% reduction in energy use for the Passenger Terminal by 2030 and
(2) To offset 50% of the Passenger Terminal energy consumption using renewable energy sources by 2030.

Constructing a microgrid would allow the Airport to make significant progress towards these 2030 goals and enhance its renewable energy generation.

Additional motivation for the project revolves around cost avoidance, adding a layer of resiliency, and becoming energy independent in the event of a power outage. This resiliency would ensure that the Airport continues providing critical services and avoids the financial losses that would occur otherwise. For example, in 2017 Atlanta-Hartsfield Jackson International Airport lost power for approximately 11 hours. The power outage was caused by a fire in an underground electric facility, which damaged two substations that served the airport. One of those substations powered the airport's redundant system that would typically provide backup power. This power outage resulted in a disruption of services and tremendous financial loss for the world's busiest airport at that time. Over 1,000 flights were cancelled, and passengers were stranded at the airport without power[1]. Delta Airlines alone lost up to $50 million due to the power outage, and even more financial losses occurred for the other airlines and the airport itself[2]. Appleton International Airport wants to ensure that a similar event, or any other event that could cause a power outage, would not negatively impact the Airport.

[1] CNN: https://www.cnn.com/2017/12/17/us/atlanta-airport-power-outage/index.html
[2] Business Insider: https://www.businessinsider.com/delta-lost-up-to-50-million-from-atlanta-airport-power-outage-2017-12

Another motivation for the project stems from the results of an initial study conducted by a consultant for the Airport. In 2021, HGA presented three potential microgrid options for Appleton International Airport. The first option would be a small, limited emergency microgrid. The second would be a microgrid where each electric feed, or building, has its own small microgrid with limited storage capacity. The third option would be a large, shared microgrid with the most storage capacity. Refer to Appendix 1 – HGA Initial Microgrid Study for Appleton International Airport in the Reference Materials. Appleton International Airport determined that the best choice would be Option 3 – the large, shared microgrid that has the most storage capacity. According to *Section 1.2.2 Applicable Definitions* in the Application Instructions, this option would be considered Level 3 because it would be a single Distributed Energy Resource (DER) serving multiple facilities and customers on multiple meters. The next step for the Airport would be to conduct a more in-depth feasibility study.

The focus of the feasibility study would be three-fold. First, the study would evaluate how to most optimally tie into the existing and future building systems. This would also include determining the optimal size for the storage systems. Second, the study would evaluate technology options for the microgrid. The core technologies of a microgrid at Appleton International Airport would include rooftop and ground-mounted solar PV, lithium-ion batteries, and generators (refer to Appendix 1 in the Reference Materials). Additional technologies that would be explored further include fuel options for the generators (i.e. renewable fuels, diesel, and natural gas), combined heat and power system (CHP), on-site electrolyzer, and green hydrogen delivery. Lastly, the study would include energy modeling software and tools to develop operational and economic modeling for the project.

The populations served would include Appleton International Airport passengers, employees, tenants, and the surrounding community. The Airport is located in east-central Wisconsin, in an area commonly known as the Fox Cities. Over 300,000 people live in the Fox Cities and are considered part of the Airport's surrounding community[3]. The Fox Cities includes over a dozen interconnected communities along the Fox River within Calumet, Winnebago, and Outagamie Counties. Some of these communities include Appleton, Neenah, Menasha, Kaukauna, Combined Locks, Fox Crossing, and Kimberly, as well as other, smaller towns and villages. Figure 1 highlights what is known as an Airport

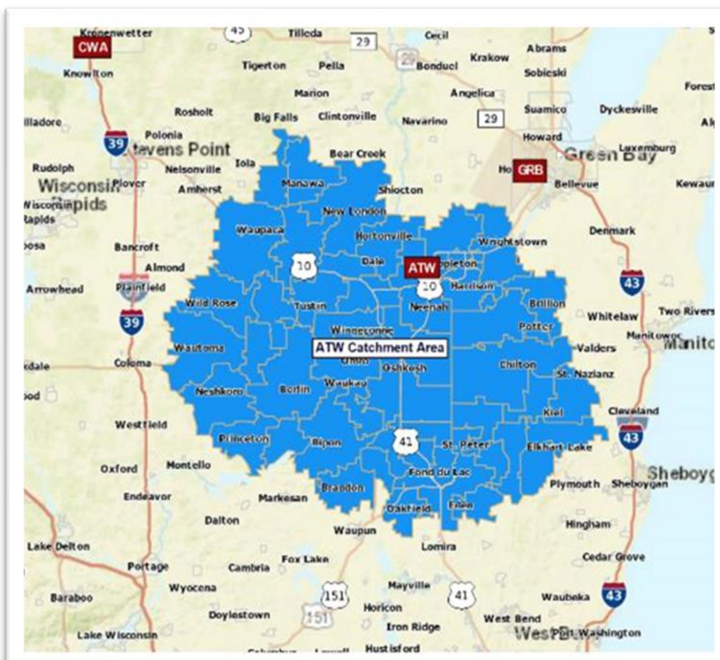


Figure 1. Appleton International Airport - Airport Service Area
Sources: ARC ticketing data, U.S. Census Bureau, and Woods & Poole Economics, Inc.

[3] Fox Cities Regional Partnership: https://foxcitiesregion.com/demographics/

Service Area (ASA). The ASA for Appleton International Airport includes the Fox Cities communities that are listed above, as well as Oshkosh, Fond du Lac, and other areas as indicated in Figure 1. Refer to Appendix 2 – Site Location Map in the Reference Materials for a more detailed map of the Airport and the surrounding community.

The U.S. Federal Emergency Management Agency (FEMA) defines a lifeline as the most fundamental services in a community that, when stabilized, enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security[4]. Lifelines enable all other aspects of society to function and include services such as law enforcement, government, fire service, agriculture, medical care, public health, power grid, communication infrastructure, aviation, mass transit, 911 and dispatch, and more. Appleton International Airport is considered a lifeline because it falls within the aviation transportation service according to FEMA guidelines.

Installing a microgrid at Appleton International Airport would further enhance the Airport's ability to provide critical services during emergencies, natural disasters, or other events that jeopardize the health, safety, and security of Wisconsin. As a staple of the Fox Cities, the Airport strives to prepare for the future, increase renewable energy generation, and improve the resiliency of the airport and surrounding community.

3.4 MERIT REVIEW CRITERIA

3.4.1 Identification of Critical Infrastructure

Appleton International Airport is considered critical infrastructure for Wisconsin because it supports the economy, safety, and security of Wisconsin. The Wisconsin Emergency Response Plan (WERP) states, "Damage to critical infrastructure such as transportation, communications, and utility systems may isolate some communities, creating islands within the disaster area.[5]" Appleton International Airport falls under the transportation category of critical infrastructure, and it is the third largest airport in Wisconsin. Services provided by the Airport include commercial flights and general aviation (GA) services, and the Airport houses a variety of tenants and business partners. Providing these aviation services and solutions, as well as fostering economic development, are a few of the reasons why the Airport is a valuable asset to the community.

Appleton International Airport supports the economy by providing jobs to approximately 22 full-time employees. Additionally, there are multiple tenants and partners located on Airport property. These partners and tenants include Air Wisconsin, Allegiant Air, American Airlines, Delta Airlines, United Airlines, the Passenger Terminal restaurant and gift shop, Gulfstream, Transportation Security Administration (TSA), Fox Valley Technical College (FVTC) Public Safety Training Center, NewView

[4] U.S. FEMA: https://www.fema.gov/emergency-managers/practitioners/lifelines
[5] Wisconsin Emergency Response Plan (WERP): https://dma.wi.gov/DMA/divisions/wem/preparedness/2017_WERP(Full37M).pdf

Technologies, Alamo Car Rental, Avis Car Rental, Budget Car Rental, Enterprise Car Rental, Hertz Car Rental, National Car Rental, Federal Express (FedEx), and Appleton Flight Center. Data shows that Appleton International Airport contributed to 2,879 jobs and provided $604.6 million in economic output in 2015[6].

Appleton International Airport supports the safety and security of Wisconsin by providing key transportation services that are considered a community lifeline by FEMA. FEMA states, "Efforts to protect lifelines, prevent and mitigate potential impacts to them, and building back stronger and smarter during recovery will drive overall resilience of the nation.[4]" The Wisconsin Emergency Response Plan also states that an energy outage may cause significant disruption to the critical infrastructure of a municipality, tribal nation, county, or state[5]. A microgrid at Appleton International Airport would be part of a solution to prevent and mitigate potential impacts to the Airport and to enhance overall resilience of the community.

The proposed microgrid would support the current Passenger Terminal and the Concourse addition buildings, as well as the proposed Concourse addition that will be constructed in the coming years. Refer to Appendix 3 in the Reference Materials for a map of the existing Passenger Terminal and Concourse building. The microgrid would support these buildings because they provide the most critical transportation services at the Airport and many tenant offices are located in these buildings as well.

The populations served would include Appleton International Airport passengers, employees, tenants, and the surrounding community. Passengers and employees would benefit from a microgrid because the Airport would be able to continue smooth operations in the event of a power outage. This means employees can be confident in their job stability and passengers can be confident that flights will continue as planned. Various companies conduct important business at the Airport. Some tenant offices are located in the Terminal building and would directly benefit from increased resilience that is associated with a microgrid. The surrounding community would benefit from a microgrid at Appleton International Airport because the Airport would be able to provide critical aviation transportation services in the event of natural disasters, prolonged power outages, and other events that might render the traditional power grid unusable. Examples of critical aviation transportation services may include the delivery of food, water, and medical supplies; the transportation of law enforcement, medical personnel, and other responders; and the ability to transport a large amount of community members out of the area if needed. These services are all listed as Community Lifelines on the FEMA website[4].

3.4.2 Key Partners and Stakeholders

Project partners for this proposed microgrid would include the following:

- Local distribution utility – We Energies
- Consultants – HGA, Mead & Hunt, and Westwood
- Federal Aviation Administration (FAA)
- Wisconsin Department of Transportation - Bureau of Aeronautics (BOA)

[6] WisDOT Bureau of Aeronautics: https://wisconsindot.gov/Documents/projects/multimodal/air/atw-eis.pdf

- Public Service Commission (PSC) of Wisconsin
- Wisconsin Office of Energy Innovation (OEI)

The roles and responsibilities of the local distribution utility include supporting the proposed project to enhance renewable energy generation and strengthen resiliency of the airport and surrounding community. We Energies could support the project by providing relevant information and data that would help the Airport complete the feasibility study and inform consultants about the design and construction of the microgrid. A letter was obtained from We Energies stating that We Energies is aware of the project and grant application, and that the company is willing to work with the Airport on the project in the future (refer to Appendix 4 – We Energies Letter).

The roles and responsibilities of the consultants may vary depending on what services the consultants are used for. Westwood, Mead & Hunt, and HGA have been consultants for previous projects at the Airport and recent discussions about this proposed microgrid have involved all three of these consultants. HGA has led most of the technical planning and design discussions related to the proposed microgrid. Refer to Appendix 5 – HGA Qualifications for details about HGA's prior microgrid projects. Other consultants may be used for this microgrid project, if needed.

The main role and responsibility of the FAA and BOA is to approve the microgrid project for the Airport. Because the project would take place on airport property, the FAA and BOA must be notified of the project and have the ability to provide comments or concerns. The project would need to be reviewed and approved by the FAA and BOA before construction of the microgrid could take place.

The level of involvement of PSC of Wisconsin and Wisconsin OEI is contingent on the results of this grant application. If Appleton International Airport is chosen as a grant recipient, PSC of Wisconsin and Wisconsin OEI would be involved throughout the entirety of the feasibility study. This involvement includes the quarterly, final, and on-request reports that are specifically mentioned in the grant application. Other requests made by PSC or OEI would also be considered high priority for the feasibility study.

Key stakeholder groups for this proposed microgrid project would include the following:

- Internal staff
- Tenants
- Passengers
- Surrounding community
- Government

The roles and responsibilities of all of the key stakeholder groups include active coordination and participation throughout the duration of the feasibility study and potential construction of the microgrid. Open communication is a key component of a successful project, and the Airport values the input of its employees, tenants, passengers, community, and the local, state, and federal government. The goal of providing open communication is to allow stakeholders to express any concerns they may have, as well as find the most beneficial outcome for all parties involved.

3.4.3 Project Resilience Objectives and Metrics

Objective #1: To improve the resilience of Appleton International Airport by producing and storing enough energy to power the Passenger Terminal and Concourse buildings independent of the traditional power grid.

> **Metric #1.1**: Measure the current energy use of the Passenger Terminal and Concourse buildings to establish baseline data. This data will help the Airport understand how much energy needs to be generated from on-site sources to meet the objective.
>
> **Metric #1.2**: Extrapolate baseline data to estimate the amount of energy that would be needed to power the Concourse addition. The microgrid should be constructed with the capacity to handle upcoming expansions in order to increase the efficiency and impact of the microgrid.
>
> **Metric #1.3**: Identify and prioritize the critical power needs of the buildings that would be supported by the microgrid.

Objective #2: To offset 50% of the Passenger Terminal energy consumption using renewable energy sources by 2030.

> **Metric #2.1**: Determine feasibility of various on-site renewable energy sources. This may include solar PV, geothermal, or other technologies.
>
> **Metric #2.2**: Determine feasible locations of the chosen on-site renewable energy sources.
>
> **Metric #2.3**: Using data from Objective #1, determine how much energy from renewable energy sources is required to offset 50% of the Passenger Terminal energy consumption.

3.4.4 Evaluation of Site-Specific Information

Appleton International Airport is situated on approximately 1,795 acres of land owned by Outagamie County. The proposed microgrid would most likely be located on the east side of Airport property near the Passenger Terminal, Concourse, and tenants. This would be the most ideal location because of its proximity to the buildings that the microgrid would support. The feasibility study would include research to determine a specific location for the microgrid, as well as potential alternative locations.

Site constraints include existing and proposed buildings and structures that would impede possible locations for the microgrid. Some of the existing buildings located on the east side of the Airport that may hinder the location of a microgrid include the Passenger Terminal and Concourse buildings, the FAA control tower, the U.S. Customs and Border Protection building, the rental car building, a fuel farm, various hangars, and the snow removal equipment building. Other constraints include any areas specifically limited by FAA regulations that cannot be constructed on, such as the Runway Safety Areas (RSA) or the Runway Object Free Areas (OFA). One major opportunity is that the airport owns a large amount of land so there should be plenty of options for the location of the proposed microgrid.

Another consideration that the feasibility study would explore is whether the proposed microgrid would be located airside or landside. Airside refers to the areas located past security that are accessible to aircraft, including aprons, taxiways, and runways. Landside refers to the areas that are open to the public, such as parking lots and indoor areas before the security checkpoint. Table 1 lists preliminary advantages and disadvantages for each location:

Table 1. Airside vs. Landside Microgrid Locations

	Advantages	Disadvantages
Airside	More secure	Harder for external maintenance to access
Landside	Easier for external maintenance to access	Less secure

Appleton International Airport utilizes existing self-generation assets. These assets include a solar thermal hot water system, solar PV, and backup generator.

The solar thermal hot water system uses solar energy to heat water for the Passenger Terminal and Concourse buildings' hot water needs. The Airport installed this system in 2010 and it includes 12 panels totaling 480 square feet, with an average annual production of 925 therms. Figure 2 shows the rooftop solar thermal hot water system at Appleton International Airport.

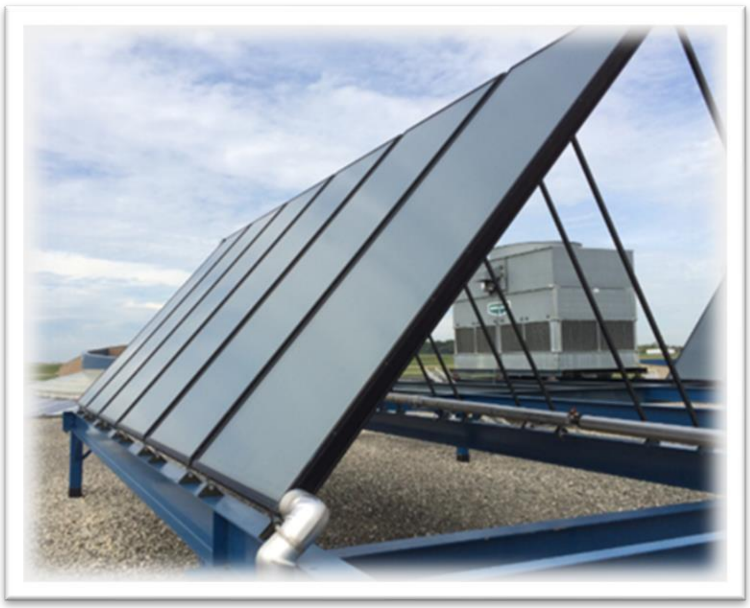


Figure 2. Solar thermal hot water system.

The solar PV assets include both rooftop systems and carport systems. In 2011, a solar PV system was installed on the roof of the Concourse building. This system includes 221 solar panels and two inverters, with an average annual production of 57,000 kilowatt hours. In 2017, the Airport installed two solar PV carport systems. The two carports make up a 230 kilowatt system with 442 solar panels. Two additional solar PV carport systems were added in 2020 to double the size of the carport system. Figure 3 shows two aerial photos of the Concourse rooftop solar and the carport solar PV systems.

Figure 3. Concourse rooftop solar PV system (left) and carport solar PV system (right).

The proposed microgrid would follow all applicable permitting requirements. These permits may be required from local entities, state governments or agencies, or federal governments or agencies. Appleton International Airport has constructed many projects in the past where multiple permits have been required from various agencies. The Airport has good rapport with various agencies and would continue to follow the permit requirements for this proposed microgrid project. Any permit requirements are not anticipated to hinder the ability or feasibility to construct this proposed microgrid.

3.4.5 Technologies Under Consideration

Appleton International Airport's proposed microgrid would primarily consist of rooftop and ground mounted solar PV, lithium-ion batteries, and generators. Additional technologies that would also be considered include geothermal heating and cooling, fuel options for the generators (i.e. renewable fuels, diesel, and natural gas), combined heat and power system (CHP), on-site electrolyzer, and green hydrogen delivery.

The microgrid would utilize rooftop and ground mounted solar PV and generators because those technologies are already in use at the Airport. Financial and efficiency benefits can be achieved by incorporating these existing technologies into the microgrid.

Lithium-ion batteries would be used for the battery storage portion of the microgrid. The feasibility study would determine the appropriate battery size and functionality of the microgrid system. The initial HGA study found that energy storage batteries have the potential to reduce the utility demand costs significantly (reference Appendix 1 – HGA Initial Microgrid Study for Appleton International Airport in the Reference Materials).

Additional generators may be added to the microgrid to increase the system's capability to support the current Terminal and Concourse buildings, as well as the upcoming Concourse addition. Fuel options for the generators would be explored in the feasibility study. These fuel options include renewable fuels, diesel, and natural gas. The Airport strives to increase renewable energy and reduce emissions, so renewable fuel options would be preferred if they are determined to be feasible.

Geothermal heating and cooling could potentially be incorporated into the microgrid. In 2013, a geothermal heat pump system was installed into the General Aviation building. The Airport is familiar with geothermal technology and feels comfortable incorporating additional geothermal systems at the Airport. The feasibility study could extrapolate operations and maintenance costs from the General Aviation geothermal system to estimate costs for a similar system in a different location on the Airport.

A CHP system could also be beneficial for the microgrid. These systems often work well with buildings that have 24/7 loads and year-round heating loads. In the case of the Airport, high outside airflow rates require large amounts of heating energy for both winter heating and summer reheat as part of the outside air dehumidification process. Therefore, a CHP system may be an economic fit for the Airport, especially as the Airport continues to develop. The feasibility study would explore this technology in more detail.

An on-site electrolyzer is another technology that could be added to the microgrid system. An electrolyzer is used to convert excess solar generation into hydrogen. The hydrogen is then used as a fuel for either the CHP system, generators, or the hydronic hot water boilers. The feasibility study would research viable products that are available on the commercial market that could meet these requirements. If on-site hydrogen generation is not feasible, the feasibility study would explore options to deliver green hydrogen to the Airport. This fuel would be used to potentially replace the current, on-site fossil burning in either the boilers or generators.

One challenge for Appleton International Airport is how to reduce emissions for building heating. Currently, the Airport uses natural gas as the heating source. Aside from air- or ground-source heat pump systems, there are limited options to retrofit existing heating systems off natural gas. Green hydrogen represents one potential emission-free path for a replacement of natural gas. While this technology is still in its infancy, the feasibility study is an appropriate place to explore options in this area. However, the detailed load and economic analysis will be focused on readily available technology.

3.4.6 Cost Match

The total cost for the feasibility study would be $242,927. This would cover the anticipated costs shown in Table 2.

Table 2. Cost Breakdown for Microgrid Feasibility Study

	Anticipated Cost	Services
Phase I	$45,000	Microgrid planning, existing data modeling, and analysis (consultants)
Phase 2	$144,500	Existing facilities capacity review, microgrid battery installation design, facility layout and installation design, battery storage facility design (consultants)
Phase 3	$38,427	Planning and integration of microgrid and other sustainable initiatives with concourse design (consultants)
Appleton International Airport	$15,000	Personnel costs related to project management, data collection, meetings, contracting, etc. would be split amongst all three Phases
TOTAL	$242,927	

Appleton International Airport is requesting $100,000 in funding from this grant. The Airport would be responsible for covering the remaining $142,927. If the Airport is awarded this grant for $100,000, it would result in a 59/41 split of the project cost, with the Airport contributing 59% and the grant contributing 41%.

Grant funding is being sought to alleviate a portion of the financial demands associated with a feasibility study for the microgrid. The project would likely proceed much faster if grant funding is awarded. The scope of the project may be larger with the grant funding than it would be without grant funding because the feasibility study would be conducted more in depth.

3.4.7 Data Collection Plan

Data collection is a key component of a microgrid project. The common saying goes, "You can't manage what you don't measure." Appleton International Airport understands that data collection is an important step in being able to track and measure progress towards its energy reduction and renewable energy goals.

Currently, Appleton International Airport utilizes the Niagara Tridium software system to track utility data. The Niagara system is a comprehensive software infrastructure that "serves as a central console for connecting real-time operational data to the people and systems that manage workflows in smart buildings.[7]" The Airport may also incorporate an analytics software called SkySpark in the future. SkySpark allows for the collection, storage, organization, analysis, visualization, reporting, and

[7] Niagara: https://www.tridium.com/us/en/Products/niagara

customization of data[8]. These systems allow the Airport to establish comprehensive data collection for its operations.

In addition to these software systems, Appleton International Airport is including a baseline inventory update in its upcoming Master Plan. The goals of an airport Master Plan are to provide a framework for long-term planning, provide an update on aviation activity, research and present preferred airport development projects, and more. The Airport's 2012 Master Plan established baseline data for various utilities, including electric, gas, and water. Westwood and Mead & Hunt are currently developing an updated Master Plan for Appleton International Airport. The updated Master Plan includes a detailed baseline inventory, which provides the last 10 years of data for electric, gas, and water utilities. The feasibility study can utilize this data for its data collection plan needs.

Continuous data collection occurs at Appleton International Airport. There are no anticipated issues related to data collection or the ability to complete the study within the grant period ending June 30, 2022.

3.4.8 Systems Sizing Analysis

Systems sizing analysis is another critical component of a successful microgrid feasibility study. The feasibility study would utilize a combination of spreadsheet tools and energy modeling software to develop operational and economic modeling for the project. Examples of spreadsheet tools and energy modeling software includes National Renewable Energy Laboratory (NREL) System Advisor Model (SAM) tool, Homer Energy, Energy Toolbase, or other custom software.

Based on the forecasted building loads, the feasibility study would determine the appropriate system sizing for the microgrid components to meet the following requirements:

- Maintain emergency loads for at least 96 hours without on-site fuel replenishment
- Maintain critical loads for at least 24 hours without on-site fuel replenishment
- Ability to maintain basic facility operation for at least 30 days without grid power
- Ability to utilize renewable energy resources during both grid connected and islanded operation
- Ability to leverage microgrid resources to reduce utility costs through load shedding, demand response, and other grid interactive processes
- Provide EV charging and discharging capabilities during grid outage to support building functions and transportation needs

As part of the resilience and reliability analysis, the feasibility study would identify events or critical environmental conditions that would impact the ability of the microgrid to meet the resilience criteria. For example, if the battery was being utilized for load shedding in the grid connected mode, the model would determine minimum levels of battery charge that would be required to provide necessary backup in case of grid failure.

[8] SkySpark: https://skyfoundry.com/product

3.4.9 Financial Analysis

As part of the economic modeling, the feasibility study would provide a detailed breakdown of the value stack of the proposed microgrid system accounting for both its grid connected and islanded services. The analysis would utilize actual utility tariffs to determine the economic benefits of the proposed systems. The individual value of the components would also be parsed out to better determine which are the most economic valuable components of the system.

The feasibility study would also look at the potential value of enrolling in an interruptible load program. The Airport would work with the local utility to explore potential options to reopen access to these demand response and interruptible load programs as part of the feasibility study.

One of the goals of the proposed microgrid project is to generate cost savings, which would be mainly achieved by cost avoidance in the event of a power outage. As described in *Section 3.3.1 Project Description*, above, Atlanta-Hartsfield Jackson International Airport lost power for about 11 hours in 2017. This power outage resulted in tremendous financial losses for the airlines and the airport itself. For reference, Delta Airlines alone lost up to $50 million from the power outage[2]. Unpredictable events, such as the utility fire that caused the Atlanta Airport power outage, are one type of the event that can cause a power outage.

Another type of event that can cause a power outage are natural disasters. Climate change is at least partly responsible for the increased frequency and intensity of storms and other natural disasters. According to the National Aeronautics and Space Administration (NASA), "adding fossil fuel emissions to the Earth's atmosphere increases its temperature," which in turn, results in more extreme precipitation[9]. Another NASA article describes how the strength of storms have changed over time. The article found a direct link between climate change and the amount of storm damage with Hurricane Sandy – the Earth's rising sea levels exacerbated Sandy's storm surge and the abnormally high sea surface temperatures likely intensified the hurricane. Some other notable findings from this NASA article include the following:

- "76% of weather stations in the United States have seen increases in extreme precipitation since 1948,"
- Hurricanes intensify significantly faster than they did in the 1980s, and
- After analyzing 120 years of data, NOAA scientists "have found that there were twice as many extreme regional snowstorms between 1961 and 2010 as there were from 1900 to 1960.[10]"

The increased frequency and intensity of natural disasters can, in turn, increase the risk of a power outage occurring at the Airport. Appleton International Airport wants to increase resiliency and become more energy independent by proactively preparing for natural disasters and unpredictable events that

[9] NASA: https://climate.nasa.gov/blog/2956/how-climate-change-may-be-impacting-storms-over-earths-tropical-oceans/
[10] NASA: https://earthobservatory.nasa.gov/features/ClimateStorms/page2.php

may cause a power outage. By preparing for such events proactively, the Airport can achieve cost savings by avoiding the financial loss that would normally occur in a power outage.

Another part of the financial analysis includes considering that this proposed microgrid project has the potential to create jobs in the future. It is unlikely that direct, internal Airport jobs would be created from this project, however, it is very likely that this project would create temporary and external jobs. For example, temporary jobs would be created due to the construction of the microgrid. External jobs that may be created in the future include continuous microgrid maintenance jobs. These jobs would help stimulate the local economy and strengthen Appleton International Airport's commitment to supporting the economic development of the surrounding community.

3.4.10 Environmental Impact

The environmental benefits that would be achieved from this proposed microgrid project are one of the main drivers and motivations for the project. Appleton International Airport has a history of prioritizing sustainability. In 2011, Appleton International Airport was one of ten airports selected by the Federal Aviation Administration (FAA) to participate in a Sustainable Master Plan Pilot Program. Two sustainability goals were created from this 2012 Master Plan:

(1) To achieve a 70% reduction in energy use for the Passenger Terminal by 2030 and
(2) To offset 50% of the Passenger Terminal energy consumption using renewable energy sources by 2030.

Since then, the Airport has worked hard to meet these 2030 goals. Appendix 7 in the Reference Materials is a timeline that highlights the various sustainable initiatives that have been implemented at Appleton International Airport since 2008. The 2030 goals are the main drivers that contributes to the desire to install a microgrid at the Airport.

To better understand the environmental impact, the EPA Greenhouse Gas (GHG) Equivalencies Calculator was used to quantify emissions reductions associated with the proposed project. Because the proposed microgrid would support the Passenger Terminal and Concourse buildings, 2020 energy use data from these buildings were used in these calculations. Table 3 provides the 2020 energy use data for the Passenger Terminal and Concourse buildings and the equivalency results from the EPA GHG Equivalencies Calculator.

Table 3. 2020 Energy Use Data and Equivalencies for Passenger Terminal and Concourse buildings.

	2020 Energy Use Data	**EPA Carbon Dioxide Equivalent**
Electricity	1,533,600 kWh	1,087 Metric Tons
Gas	72,269 therms	382 Metric Tons
TOTAL		1,469 Metric Tons

Table 3 shows that the 2020 electricity and natural gas usage at Appleton International Airport's Passenger Terminal and Concourse buildings equals 1,469 metric tons of carbon dioxide emissions. For reference, this is equivalent to the GHG emissions from 319 passenger vehicles driven for one year or 267 homes' electricity use for one year[11].

To calculate greenhouse gas emissions that were offset by on-site renewable energy sources, 2020 data was entered into the EPA GHG Equivalencies Calculator. The two on-site renewable energy sources that contributed to the offsetting of carbon dioxide emissions were solar PV from the rooftop and carport systems and the solar thermal hot water system. Table 4 provides the 2020 energy production data from the Passenger Terminal and Concourse buildings and the equivalency results from the EPA GHG Equivalencies Calculator.

Table 4. 2020 Energy Production Data and Carbon Dioxide Emission Offset Equivalencies for Passenger Terminal and Concourse Buildings.

	2020 Energy Production Data	EPA Carbon Dioxide Equivalent (as offset)
Solar PV	618,959 kWh	439 Metric Tons
Solar Thermal Hot Water	925 therms	4.9 Metric Tons
TOTAL		443.9 Metric Tons

Appleton International Airport currently utilizes self-generating renewable energy sources to power a portion of the energy needs for the Terminal and Concourse buildings; however, the Airport wants to increase the amount of on-site, renewable energy sources so that additional emissions reductions can occur. There are many opportunities for the Airport to increase on-site renewable energy sources on the Airport's 1,795 acres of property. Because the size of the proposed microgrid has not yet been determined, it is difficult to quantify the amount of emissions reductions that would be achieved with this microgrid project. It is assumed that the microgrid would tie into the existing on-site solar PV systems and the solar thermal hot water system at the Terminal and Concourse buildings, so it is known that 443.9 metric tons of carbon dioxide emissions would be offset. The feasibility study would determine the type and amount of additional on-site renewable energy technologies that could be incorporated into the microgrid project.

Appleton International Airport is passionate about sustainability and motivated to move forward with this proposed microgrid project. Appleton International Airport strives to be a sustainability leader in the airport industry. This proposed microgrid project at Appleton International Airport could be used as a model for other airports to follow.

3.5 REFERENCE MATERIALS LIST

1. HGA Initial Microgrid Study for Appleton International Airport
2. Site Location Map
3. Existing Terminal and Concourse Building Map

[11] EPA: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

4. We Energies Letter
5. HGA Qualifications
6. Timeline of Sustainable Initiatives

Appendix 1. HGA Initial Microgrid Study for Appleton International Airport

Microgrid for Appleton International Airport

Appleton International Airport has several large renewable energy systems that would integrate well with a microgrid and a battery storage system. Combining these systems could enable the airport to operate even when there is a utility power outage. In addition, it would enable the airport to add more renewable energy systems to the terminal without selling back to the utility (at a low energy rate). The energy storage batteries also have the potentially to reduce the utility demand costs significantly.

The current terminal and concourse are served through two separate electrical feeds and meters and we have assumed that the new concourse also will have a separate electrical feed including an emergency system.

Design assistance fee (drawings and specifications by others) for a Microgrid for existing Terminal, Concourse and New Concourse: $104,000

Opinion of cost for Microgrid construction will be strongly dependent on battery size and functionality of Microgrid system as well as the required alterations and upgrades for the existing systems. Below are possible microgrid options for Appleton International Airport:

Option 1- Existing Emergency Circuit powered by Solar PV and Batteries. Assuming existing generator(s) can be integrated, and PV already installed or in a different budget for the new concourse.

Option 2- All Building Loads powered by microgrid with Solar PV, Batteries and Generator. Includes upgrading generators. Assumes PV already installed or included in different budget.

Option 3- All building connected to central microgrid. Similar to option 2 but one microgrid in lieu of three separate systems and with a much larger battery capacity. Additional PV is not included.

Table 1: Opinion of cost for each option and electrical feed (building). These costs do not include any architectural modifications if required.

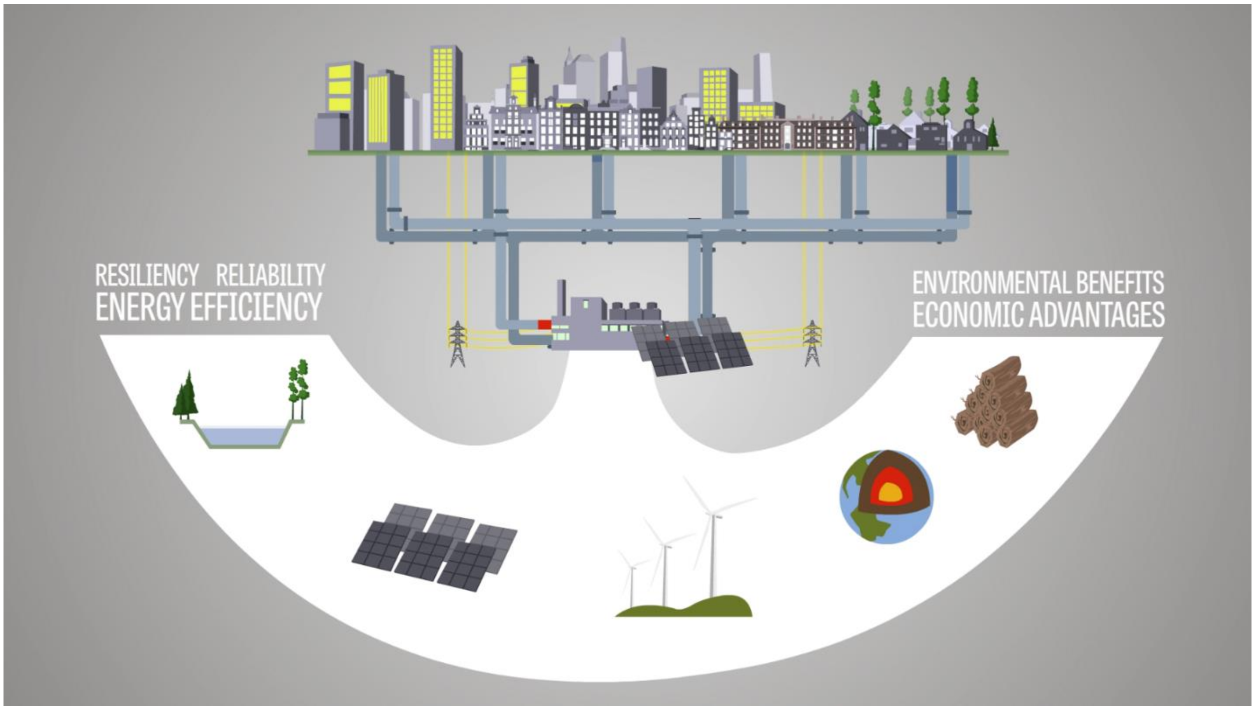
<table>
<tr><th></th><th>Option 1</th><th>Option 2</th><th>Option 3</th></tr>
<tr><td>New Concourse</td><td>$350,000</td><td>$500,000</td><td rowspan="3">$9,000,000</td></tr>
<tr><td>2000 Concourse</td><td>$500,000</td><td>$900,000</td></tr>
<tr><td>Original Building (Terminal)</td><td>$1,100,00</td><td>$2,000,000</td></tr>
</table>

Microgrid Features

Microgrids are a growing segment of the energy industry, representing a paradigm shift from remote central station power plants toward more localized, distributed generation—especially in cities, communities and campuses. The power to isolate from the larger grid makes microgrids resilient, and the ability to conduct flexible, parallel operations permits delivery of services that make the grid more competitive.

By “islanding” from the grid in emergencies, a microgrid can both continue serving its included load when the grid is down and serve its surrounding community by providing a platform to support critical services from hosting first responders and governmental functions to providing key services and emergency shelter.

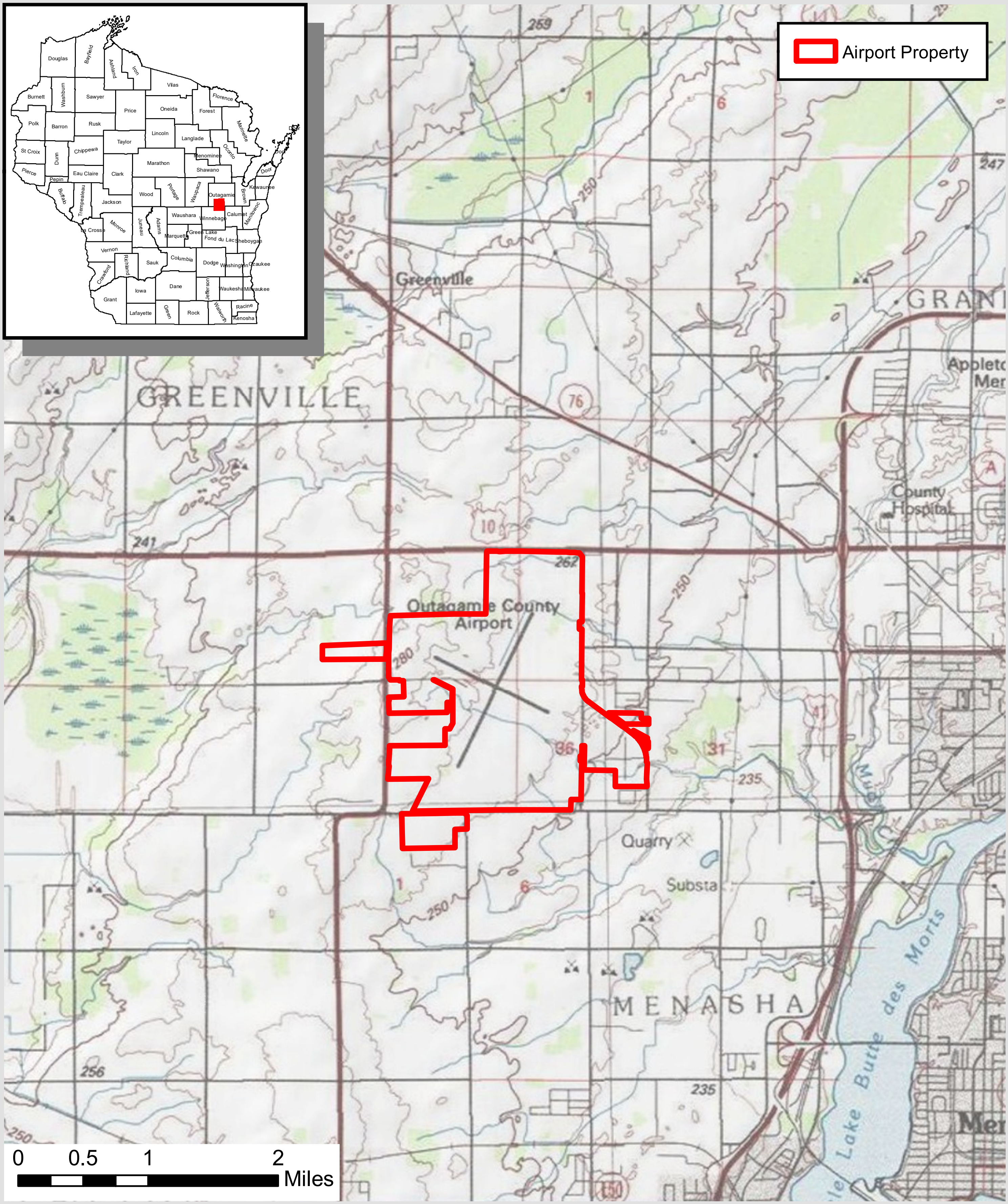
Microgrids provide efficient, low-cost, clean energy, enhance local resiliency, and improve the operation and stability of the regional electric grid. They provide dynamic responsiveness unprecedented for an energy resource.



Benefits of Microgrids

- Provide efficient, low-cost, clean energy
- Improve the operation and stability of the regional electric grid
- Critical infrastructure that increases reliability and resilience
- Reduce grid “congestion” and peak loads
- Enable highly-efficient Combined Heat and Power (CHP), reducing fuel use, line losses, and carbon footprint

- Integrate CHP, renewables, thermal and electric storage, and advanced system and building controls
- Make Regional Transmission Organizations (RTO) markets more competitive
- Offer grid services including: energy, capacity, and ancillary services
- Support places of refuge in regional crises and first responders
- Use local energy resources and jobs
- Diversified risk rather than concentrated risk
- Using electric and thermal storage capabilities, a microgrid can provide local management of variable renewable generation, particularly on-site solar
- When properly designed, a regional power grid that combines both large central plants and distributed microgrids can be built with: less total capital cost, less installed generation, higher capacity factor on all assets, and higher reliability.



Westwood

1 Systems Drive
Appleton, WI 54914
(920) 735-6900
www.westwoodps.com

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APPLETON INTERNATIONAL AIRPORT

SITE LOCATION MAP

APPLETON INTERNATIONAL AIRPORT
TOWN OF GREENVILLE, OUTAGAMIE COUNTY, WISCONSIN

Project Manager:		SCALE: 1 " = 5,280 '	
Project Engineer:			
Drawn By:	JMD	PROJECT NO. N/A	
Checked By:			
Date:	8/2/2021	FIGURE NO. 2	

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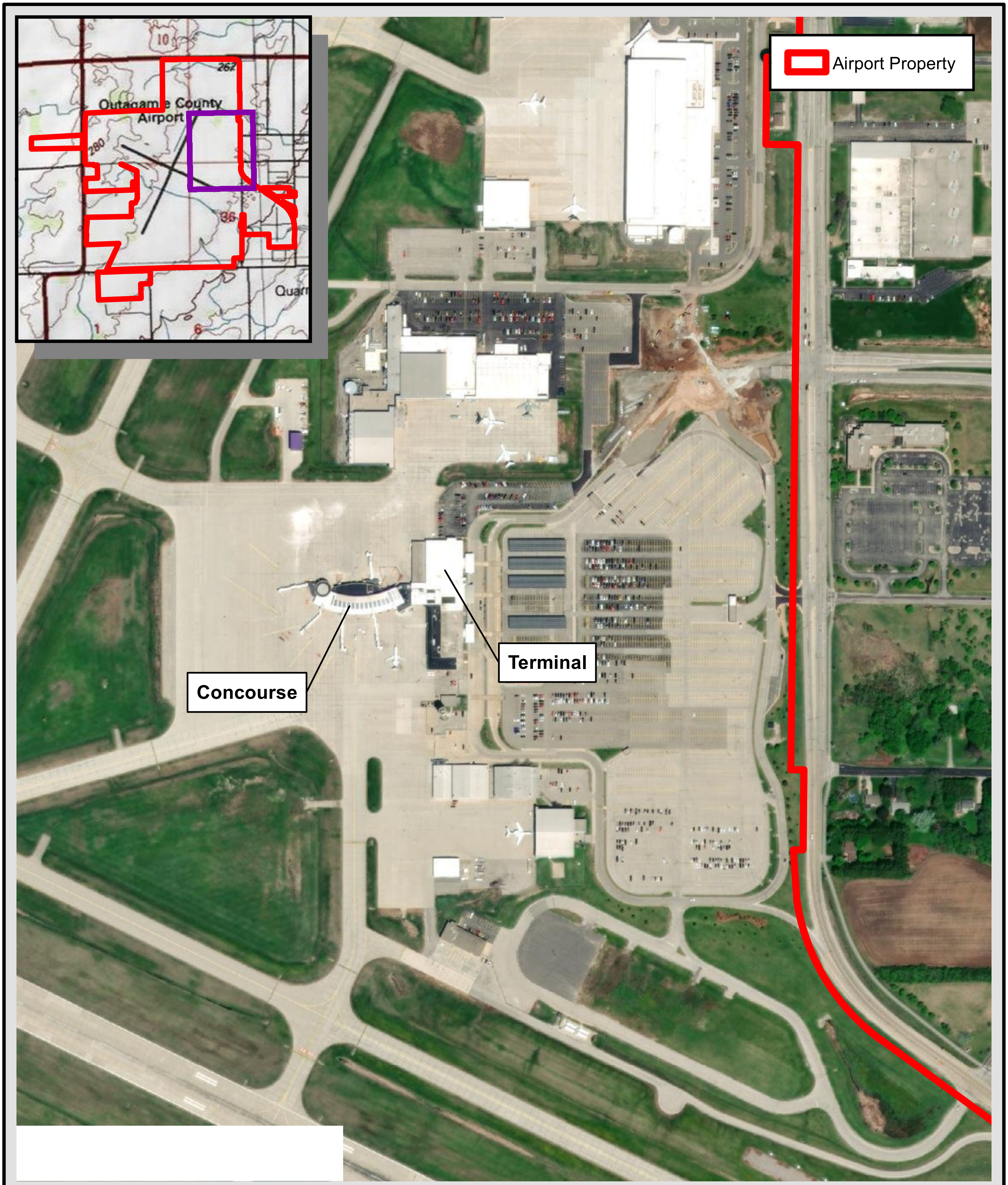

Westwood 1 Systems Drive (920) 735-6900 Appleton, WI 54914 www.westwoodps.com	N W E S	***APPLETON INTERNATIONAL AIRPORT*** **EXISTING TERMINAL AND CONCOURSE** APPLETON INTERNATIONAL AIRPORT TOWN OF GREENVILLE, OUTAGAMIE COUNTY, WISCONSIN	Project Manager: Project Engineer: Drawn By: JMD Checked By: Date: 8/2/2021	SCALE: 1 " = 417 ' PROJECT NO. **N/A** FIGURE NO. **3**

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Appendix 4. We Energies Letter

we energies

August 4, 2021

Public Service Commission of Wisconsin
and
Wisconsin Office of Energy Innovation

Re: Appleton International Airport's Critical Infrastructure Microgrid / Community Resilience Center Grant Application

Dear PCS of Wisconsin and Wisconsin OEI:

We Energies is aware of Appleton International Airport's project for which it has applied for an Office of Energy Innovation grant.

As with any other similar project that requires interconnection with its distribution system, We Energies will work with the Appleton International Airport to evaluate its interconnection application under PSC 119.

We have provided electric service to the Appleton International Airport for many years. We understand the importance of providing consistent, reliable power to the airport so, in turn, the airport can continue smooth operations. Appleton International Airport is a major economic driver of the surrounding community.

Sincerely,

Tom Young

Tom Young
We Energies Service Manager
920-380-3489

HGA

ARCHITECTURE AND ENGINEERING QUALIFICATIONS

MICROGRIDS

Marquette University | Milwaukee, WI

ABOUT HGA

HGA is a national multi-disciplinary design firm rooted in architecture and engineering. Founded in 1953, we believe that enduring, impactful design results from deep insight into the people and passions that animate each unique environment. Nearly 800 people in eleven nationwide offices work to make a positive, lasting impact for clients. We re a catalyst for positive change—applying intelligent thinking and industry expertise to projects across all of our markets—from initial advisory services to working on design and operation projects.

Front Cover: HGA Madison (WI) Office | (nearly) Net Zero Energy Building

Our approach offers tools and documentation on the advantages, disadvantages and economics of key options to help you make informed and educated decisions. Whether tackling small projects like energy audits or designing significant new facilities, we are industry leaders in optimizing and implementing systems that best fits the current and future needs of our clients. We deliver reliable, resilient, effective, and sustainable infrastructure systems that are integrated into their environments.

WE ENABLE OUR CLIENTS TO:

- Reduce use of energy and resources, decreasing environmental impact and operating costs
- Protect financial resources by limiting exposure to energy market volatility
- Optimize current physical resources by assessing them for energy efficiency and reliability
- Seek LEED or other third party certifications

Arizona State University Student Pavilion | Tempe, AZ

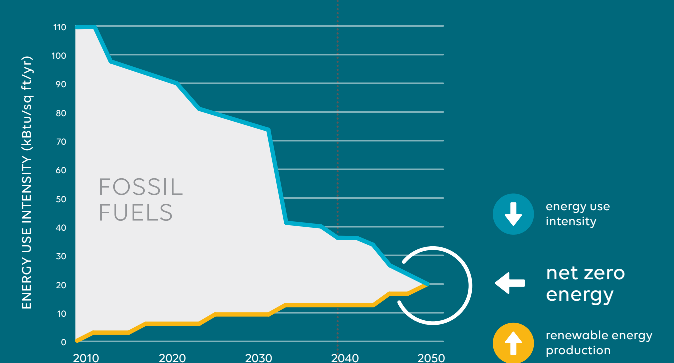
A CLIMATE POSITIVE FUTURE WITH NET ZERO ENERGY

We are committed to meeting our clients' goals as well as challenging our industry. This means developing the expertise and research to push beyond net zero energy to net positive energy; from a neutral effect on health, safety, and resources to a positive one. As the need and desire for sustainable environments grow, so does the focus on high-performance buildings with sound data that we can share back with clients and our design teams.

Sutter Health Santa Rosa Regional Hospital | Santa Rosa, CA

HGA has design experience with various generation resources and energy storage—microgrid, combined heat and power, internal combustion engine generation, biomass facilities and biomass-based district energy systems, biodigesters, building mounted solar thermal and photovoltaics, photovoltaic building skin design, geothermal systems, wind generation, landfill gas, and more. Alternative equipment options can improve energy efficiency and reduce maintenance and operational costs. We consider the complexities of energy supply, energy generation, and building loads in the context of our clients' facility needs—present and future—and evaluate the feasibility and life-cycle cost of these alternatives to help owners justify the investment.

POTENTIAL PATHWAY TO NET ZERO ENERGY



PLANNING FOR A RESILIENT, RENEWABLE FUTURE

Our engineers have been partnering with clients to deliver creative, viable pathways to a cleaner, more resilient energy future for decades. Whether we leading assessments to explore solar PV applications with hydrogen energy storage systems or evaluating more traditional battery and thermal storage, we are industry leaders in optimizing and implementing systems that best fits the current and future needs of our clients.

HGA SUSTAINABILITY STATS

202
LEED PROJECTS
(CERTIFIED & REGISTERED)

17
NET ZERO ENERGY PROJECTS
(IN-PROGRESS, PLANNED & COMPLETE)

01
LIVING BUILDING CHALLENGE
(IN PROGRESS)

04
WELL PROJECTS
(CERTIFIED & REGISTERED)

657
PROJECTS REPORTED TO ARCHITECTURE 2030

TOP "ZERO ENERGY" ARCHITECT

BY NEW BUILDING INSTITUTE

ARCHITECTURE 2030 INITIATIVE

FOUNDING SIGNATORY

NATIONAL ENVIRONMENTAL STEWARDSHIP

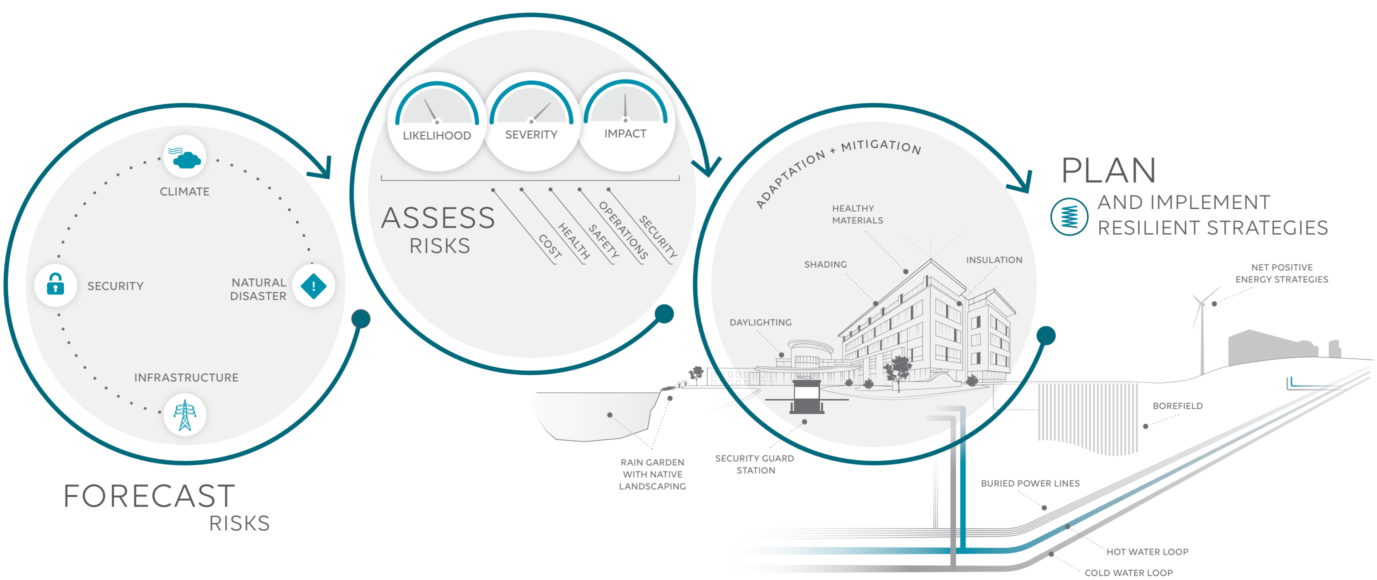
AWARD WINNER

RENEWABLE ENERGY GENERATION SYSTEMS

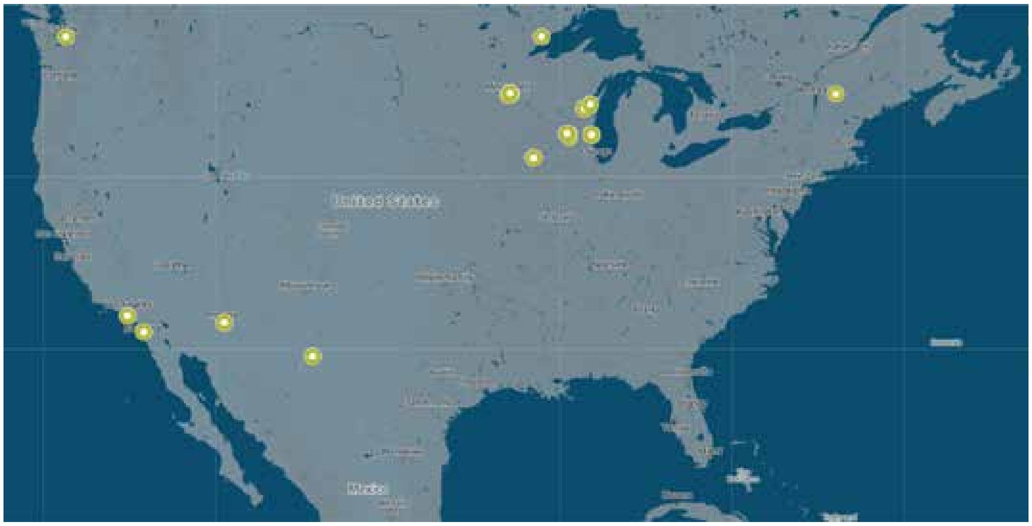
Renewable energy generation systems hold the potential to reduce overall emissions, invest in local sources of energy, and reduce the lifecycle cost to operate facilities. However, even with renewable energy sources, the overall efficiency and associated emissions are linked to the proper operation of each facility. We evaluate energy consumption and provide specific recommendations that will optimize lifecycle costs for the facilities.

The viability of a Renewable Energy generation system varies significantly with building load profiles and site location. A building's peak load represents only a fraction of the total energy consumed annually. Therefore it is critical to evaluate all available energy sources at the site to optimize the size of the renewable energy generation system. HGA will consider the complexities of energy supply, energy generation and building loads to evaluate the feasibility and costs of upgrading the existing infrastructure to meet current and future needs. We evaluate these solutions from a business planning perspective and find the optimal economic solution that meets reliability, environmental, and social requirements. Financial success is interwoven into development of our solutions from the beginning concepts through final design.

We consider energy in all of its forms: electricity, natural gas, chilled water, hot water, steam, solar, ground source heat pumps, woody biomass, food waste and animal waste. Planning for energy supply needs will help to manage the volatility in energy costs, communicate the emissions associated with energy consumed onsite, and reduce lifecycle costs. We consider energy supply in the context of energy demand from your facility needs—present and future.



HGA'S RESILIENCY PROJECTS



INSTALLED SOLAR PV PROJECTS

GENERATOR-O

Forest Edge Elementary School | First Net Zero School in the State of Wisconsin

NLY PROJECTS

MICROGRID PROJECTS

HGA'S RECENT PROJECTS

OREGON SCHOOL DISTRICT | NEW NET ZERO ENERGY ELEMENTARY SCHOOL | OREGON, WI

HGA has worked with Oregon School District for the past ten years, providing a variety of energy consulting, commissioning, retro-commissioning and engineering design services—most recently, a new net zero energy (NZE) elementary school which creates a model for sustainability in the community. With NZE as a driving factor, HGA was engaged as a net zero energy/net zero carbon expert in order to help to achieve that goal. Our team provided energy consulting, energy modeling, and design services for renewable energy systems. We helped the district establish energy targets early in the design process to make sure efforts aligned with NZE "best practices". The scope includes state-of-the-art energy efficiencies, such as a highly innovative system design for on-site microgrid/battery storage, a 740kW solar PV system, and a geothermal heating/cooling system. HGA is also providing commissioning to confirm the building is constructed to meet the design criteria and achieve the client's goals for sustainability.

RAMSEY COUNTY | SOLAR FEASIBILITY ENGINEERING ANALYSIS | MAPLEWOOD, MN

Ramsey County wanted to install rooftop solar PV systems on existing County buildings to generate clean energy on-site and reduce greenhouse gas emissions. The feasibility study, performed by HGA, provided the documentation, strategies and tools needed to work toward their carbon reduction goals. The County identified a list of 20 buildings for the study, which evaluated roof conditions, site potential, structural capacity and existing electrical systems to identify "shovel-ready" sites for rooftop solar. In addition to assessing the existing conditions, the team estimated the cost for installing rooftop solar at those sites, and performed solar analysis using modeling software to determine kWh production and estimate the annual solar generation. Six buildings were identified as shovel-ready with roof areas that will allow for a cumulative 647 kW (dc) of photovoltaic capacity, or 600 kW (ac). Average electric production from these 6 photovoltaic arrays would generate 835,700 kWh annually, and would help the County avoid 716,195 lbs CO_2e annually, or 325 metric tons CO_2e. In addition, the County can benefit from reduced utility costs, enhanced resiliency, and an increase in the region's capacity for clean energy generation.

PINCANNARX | COMMISSIONING FOR HEADHOUSE AND GREENHOUSE | PINCONNING, MI

Pincanna RX is a licensed cannabis grower and processor in Michigan. The new Pinconning facility is a headhouse and greenhouse in a remote area of Michigan. Due to significant power demand for grow lights, the facility is designed to generate all of its own power and will not be connected to the electric utility. This project includes natural gas combined heat and power (CHP) units totaling 2.6 MW. Since the growing operation is inside, the HVAC system needs to tightly control airflows, temperature, humidity and CO2 concentrations for plants to thrive. To supplement indoor CO2 concentrations, a scrubber cleans the exhaust from the CHP generators and supplies the carbon dioxide to the plants to support growth. This improves energy efficiency and reduces the environmental impacts from this operation.

HGA led the commissioning process and developed performance testing procedures to verify the building systems, particularly the mechanical and electrical systems, are operating per design. Given the significant interactions between electrical equipment and mechanical systems, HGA's operational focus helped the design team and contractors finalize sequences of operation, switching, and programming for scenarios where a generator or load goes offline (Demand Response programming).

WISCONSIN AIR NATIONAL GUARD | ENERGY RESILIENCY PROJECT & MICROGRID | MILWAUKEE, WI

Kevin Standlee (HGA) began this project by documenting and analyzing the existing electrical infrastructure and load information for the 89-acre base. From there, he developed a concept design that reconfigures services, incorporates an existing 2.25MW solar field, 1MW of new energy storage and multiple networked emergency generators all tied together on a microgrid controls network. This concept design will

DANE COUNTY | HIGHWAY FACILITY | MADISON, WI

The new Highway Facility Building includes 150 kW of photovoltaic panels, and houses maintenance equipment and administrative office space for the Dane County Highway Department. HGA provided energy modeling for cost effective design choices, a feasibility study for solar

HGA

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Milwaukee, WI 53202

414.278.8200
HGA.COM

Appendix 6. Timeline of Sustainable Initiatives

Previous Sustainable Initiatives at Appleton International Airport

2008
- Facilities assessment
- Biofiltration basin

2009
- Ground power and pre-conditioned air units

2010
- Solar thermal hot water system
- De-icing storage facility

2011
- FAA Sustainability Master Plan Pilot Program
- Solar panels – main concourse

2013
- South GA Terminal constructed

2014
- High efficiency boilers upgrade
- South GA Terminal solar panels installed

2015
- Passenger Terminal retro-commission study
- CO_2 demand ventilation system

2016
- Gulfstream North Hangar retro-commission study

2017
- Solar carports installed

2020
- On-site hydroponic farming system

Various Years
- LED lights and HVAC upgrades
- Vending machine sensors
- VFD in air handlers
- Waste oil furnace